Evaluating Changes in Clinical Decision-Making in Physical Therapy Students After Participating in Simulation

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Abstract

Purpose: Physical therapy students are not consistently prepared to practice in the dynamic healthcare environment immediately after graduation. Implementing other teaching modalities may help to better prepare physical therapy graduates. Medical and nursing student education have effectively used simulation to help prepare students for clinical practice. The purpose of the quasi-experimental design study was to assess the effect of simulation on clinical decision-making (CDM) in Doctor of Physical students in a physical therapy program.

Methods: One-hundred and twenty-two students in two class years participated in the study, with 71 partaking in a simulation activity and 51 students serving as the control. The first-year students participated in a task trainer simulation and the second-year students completed a hybrid simulation. The students' CDM was measured prior to and after completing the simulation.

Results: The results demonstrated that the students who participated in simulation had statistically significantly higher scores on the CDM Tool than the students who did participate in simulation. The results also further validated the CDM Tool by demonstrating that second year students had significantly higher scores on the CDM Tool than first year students at both time points.

Discussion: Students demonstrated statistically significant changes in CDM after participating in one simulation experience. Further research is required to replicated these results and determine the optimal dosage of simulation experiences for long-term learning.

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1. Introduction

Physical therapists working in today's healthcare environment need a different skill set than 30 years ago.[1] The American Physical Therapy Association (APTA) outlines several roles that physical therapists must play: independent; lifelong learners; patient advocates; skilled diagnostic screeners; evidence-based practitioners; responsibility for moving the profession forward; and practitioners of choice of clients for movement related issues.[1,2] To meet these needs, physical therapist education programs in the United States increased clinical education time and

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added coursework to curricula to meet the prerequisites of a doctoral degree as the profession transitioned from bachelors and masters level training.[3] However, the focus in some physical therapy programs has been on educating for competency, or the ability to complete skills, more than capability, which involves problem solving and decision-making.[4] Education focused on competency is not sufficient to prepare graduates for today's healthcare environment.[5] Inadequately prepared students pose a risk to patients' safety if they cannot make correct clinical decisions.[6] Additionally, practice settings become burdened with training new graduates to meet the healthcare environment's requirements where schools failed, incurring further costs.[7,8] Therefore, educational methods must be modified to better prepare students for clinical practice.

Simulation is an active learning technique frequently employed in medicine and nursing education that addresses some of the roles of physical therapists outlined by the APTA.[9,10] Simulation re-creates a clinical setting or scenario as a learning or testing environment.[11] Simulation can include high fidelity interactions with a manikin, standardized patients, virtual reality, or computer-based cases. Simulation and post-simulation debriefing gives students the opportunity to practice skills repeatedly in a controlled environment, which decreases patient risk and increases standardization across experiences.[9,12–14] Simulation participation leads to increased efficiency in student learning; decreased student clinical time and placements needed, decreased risk to patients, and decreased demand on clinical faculty for teaching.[9,10,15,16] Simulation focuses on educating students for capability.[4]

Physical therapy has begun to adopt simulation as an educational modality. Some current evidence supports the use of simulation in physical therapy.[17–39] The majority of the evidence in physical therapy has looked at students' reactions to participating in simulation or if the student learned a specific skill or task. More research is needed to demonstrate that simulation facilitates behavior change or to evaluate the transfer of didactic knowledge to clinical situations in physical therapy students. Therefore, the purpose of this study was to assess the effect of simulation on clinical decision-making (CDM) in Doctor of Physical Therapy (DPT) students at the MGH Institute of Health Professions (MGH IHP).

2. Method

2.1. Subjects

Two cohorts of DPT students at the MGH IHP were studied based on their class year. All students enrolled in the DPT Classes of 2017 (second-year students) and 2018 (first-year students) were eligible. There were no exclusion criteria. Demographic data was not collected as part of the study, but program demographic data for each class was available (see Table 1).

2.2. Procedure

All students in the DPT classes participate in simulation activities. During the Fall 2015 semester, the first-year students were randomly assigned to either a simulation or control group by a random number generator. In the Spring 2016 semester, the second-year students were assigned to a simulation or control group based on the timing of their clinical education assignments. Thus, true randomization was not possible. Additionally, allocation was not blinded.

Students voluntarily participated and consent was implied if they completed the CDM Tool. No identifying data were collected and the responses were anonymous. Study data were collected and managed using REDCap (Research Electronic Data Capture), an electronic data capture tool.[40] REDCap is a secure, web-based application designed to support data capture for research studies.

Five days prior to the respective simulation experiences, the students completed a baseline self-report CDM measure. After the simulation experience, the students were asked to evaluate their CDM skills again on the same tool. All first-year students completed the

Table 1
Demographic information of sample.

Cohort	Average Age	Gender	Race
Class of 2017	24 years old	61% Female	Asian 17%
			Black 3%
		39% Male	Hispanic 6%
			White 45%
			Unknown 9%
Class of 2018	25 years old	80% Female	American Indian 1%
			Asian 14%
			Black 10%
		20% Male	Hispanic 7%
			White 53%
			Unknown 14%

reassessment 5 days after the initial assessment, on the day of the simulation experience. The second-year students completed the assessment between 5 and 21 days after the initial assessment, again on the day they completed the simulation. The second-year students' simulation experience could not all be scheduled on the same day due their clinic schedules. The students in the control group completed the CDM assessment at the same times, but without having completed a simulation experience.

2.3. Clinical decision-making tool

The outcome measure used was the CDM Tool created by Brudvig and Macauley[41] to assess student outcomes. It is a 25-item tool modified from select sample behaviors of the Physical Therapy Clinical Performance Tool.[42] The tool includes items about recognizing changes in patient status, gathering and synthesizing information to make decisions, referring patients to healthcare providers, and creating intervention plans congruent with data. Items are assessed on a 6-point Likert scale where students self-assess the level of assist they require to complete the items on the scale. The lowest level of the scale is "I do not know how to do this" and the highest level is "I am capable of teaching this to others in the clinical setting." CDM scores were determined by assigning each level of the Likert Scale a number, one through six. Each student's score across the 25-items was summed to give a total score.

The CDM tool demonstrated face validity[41,43] Macauley et al. [accepted for publication] assessed the psychometric properties of the scale via serial Rasch analyses. The tool was modified after each data collection and the third version of the tool was used for the current study. The tool demonstrates good internal consistency with a Cronbach's alpha > 0.99.

An a priori power analysis, assuming an effect size of 0.5 since it was educational research, determined a sample size of 105 was needed for power $= 0.80$.[44] A sample size of 105 requires a response rate of 75%, which is higher than an average response rate, but consistent with educational research response rates.[45] The Spaulding Rehabilitation Hospital and University of Phoenix institutional review boards both deemed the study exempt from full review.

2.4. Simulation experiences

2.4.1. Second-year student simulation experience

The simulations were hybrid simulations, with a standardized patient (SP) playing a patient case. The SP was "connected" to a cardiac monitor controlled by a faculty member in another room. The faculty member manipulated the vital sign information via a wireless connection to a SimMan 3 G manikin that was kept out of view of the students. The SimMan 3 G manikin is an adult patient simulator that can replicate neurological, circulatory, and respiratory dysfunctions.[46] The SP was trained by the course faculty to act out the hemodynamic response as it occurred on the monitor. The scenarios were pre-planned between the SP and the faculty.

Two cases were used: an 89-year-old woman with a stroke and new onset atrial fibrillation and a 70-year-old woman with pneumonia and shortness of breath. In each case, a potential clinical decision-making point was emphasized: reacting to an orthostatic response, new onset arrhythmia (atrial fibrillation or supraventricular tachycardia), or oxygen desaturation. The students began their assessment or intervention, and the scenario unfolded depending upon the student plan and decisions. The simulations lasted approximately 15–20 min, which was dependent on the timeliness of student decision-making. The simulation was terminated when the faculty member felt that the students had made an appropriate decision to manage the emerging clinical data and the patient was managed safely. The decision to terminate was based on the faculty member's clinical judgment. On rare occasions, the students froze and were unable to make a clinical decision, and the simulation was terminated.

The students performed the simulation in groups of four. Two students completed the experience while the other pair observed with the faculty. After the first simulation was completed, the pairs switched roles. Both pairs had the same case at different times in the patient's clinical course, but the students were not privy to this information. When the second pair of students participated in the simulation, they faced a different clinical decision than the first pair.

After both pairs of students completed the simulation, debriefing with the faculty and SP occurred for approximately 25–30 min. The SPs were trained by the course faculty to comment on the students' communication skills. The debriefing technique used was

Class 2017
(2ⁿᵈ Year)
n=71

Class 2018
(1ˢᵗ Year)
n=65

CDM Tool: Time 1
Responses: n = 69
(2 no responses)

CDM Tool: Time 1
Response: n= 64
(1 no response)

CDM Tool: Time 2
Response: n = 64
(5 no responses)

CDM Tool: Time 2
Response: n = 61
(3 no responses)

Simulation
Group
n=35

No Simulation
Group
n=27
2 missing data

Simulation
Group
n=44
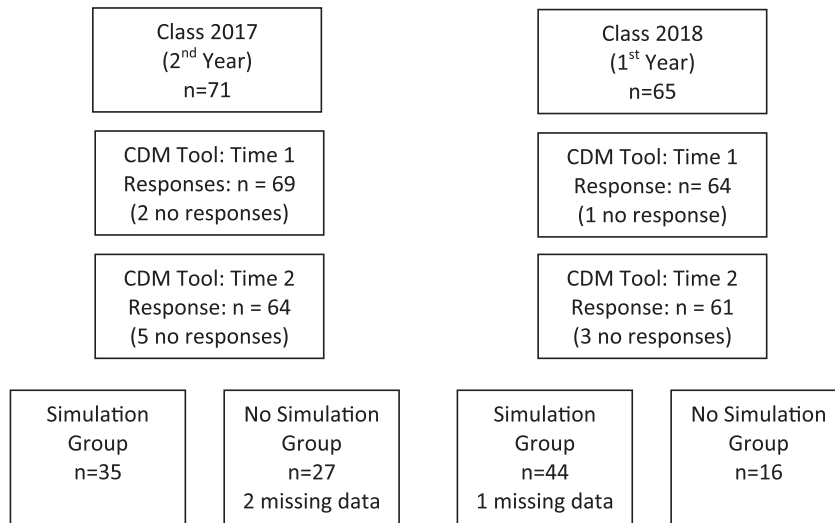1 missing data

No Simulation
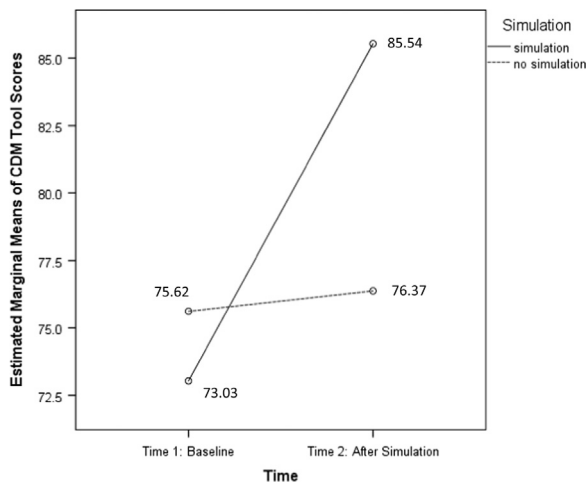Group
n=16

Fig. 1. Response for both cohorts.

Fig. 2. The simple effect of time and simulation, or the interaction between time (pre- and post-test) and simulation groups, is depicted.
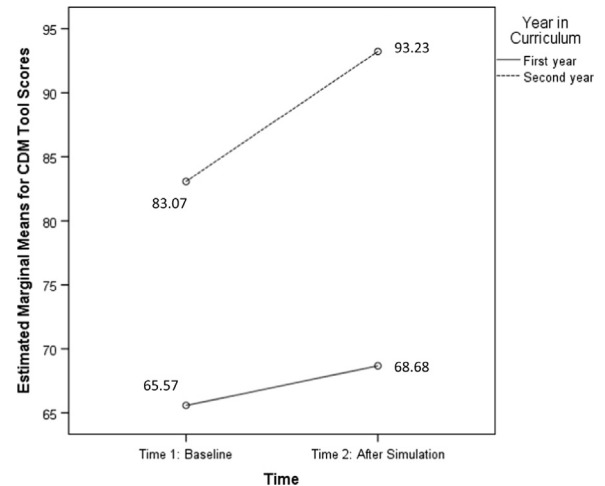

Fig. 3. Simple effect of time and class year. The figure shows the interaction between time (pre- and post-test) and class year.

debriefing with good judgment.[14] The faculty member was trained in this method through the Center for Medical Simulation and had five and a half years of experience using it in simulated experiences.[47]

2.4.2. First-year student simulation experience

The simulation experience involved SAM II Student Auscultation Manikin.[48] Two board certified clinical specialists in cardiovascular and pulmonary physical therapy operated the manikins and led the small group discussions. In groups of five or six, students listened to preprogrammed lung and heart sounds on the manikin. The students listened to the sounds, reported on what they heard, and the faculty facilitated a discussion about each

sound. The discussion centered on technique for auscultation, identifying the sound, assigning the correct name, clinical scenarios when each abnormal sound would be heard, and possible physical therapy interventions to address each sound. The sounds included crackles and wheezes. Each simulation session lasted 20 min.

2.5. Data analysis

Descriptive statistics were used to describe the response rates, gender, and class year of the data set. A three-way, mixed ANOVA with time as a repeated measure was used to determine the differences between groups over time. Predictor variables included class year

(2017 or 2018), simulation or no simulation, and time, before or after simulation experience. The outcome variable was CDM, which was measured by the CDM Tool.[41,43] There was particular interest in the interaction between time and group. Students with incomplete CDM tools were removed from the analysis. All analyses were completed with SPSS, version 24.[49,50]

3. Results

The second year class had 65 students and the first year class had 71 students. Specific demographic data were not collected from the students who participated. However, greater than 90% of the students participated in the study so the MGH IHP DPT program data provides an adequate description of participants. The students mean age was 24 to 25 years, were mostly female, and white. See Table 1 for details.

Prior to the simulation experience, 97% ($n = 69$) of the second year students and 98.5% ($n = 65$) of the first year students completed the CDM tool. Following the simulation experience, the second year students had an initial response rate of 93% ($n = 64$), with two additional participants eliminated during analysis due to incomplete data, yielding a final rate of 90% ($n = 62$). After the simulation, the first year class had an initial response rate of 95% ($n = 61$), with one participant eliminated due to incomplete data, giving a final rate of 94% ($n = 60$). See Fig. 1 for the responses for each class.

In the first year class, 35 students were randomized to the simulation group and 36 to the control group. All missing data and no responses were in the control group. In the second year class, scheduling constraints resulted in more students in the simulation group ($n = 45$) than the control group ($n = 16$). A post-hoc power analysis conducted on this sample size yielded a power $= 0.92$ by G*Power, version 3.1.9.2.[51]

There was a significant interaction between time and participation in simulation, $F (1, 118) = 28.070, p < 0.001$. See Fig. 2, where simulation indicates participation in either a task trainer or hybrid simulation experience. Upon further examination of the simple effects, there was a significant difference between groups post-simulation, $F (1, 118) = 11.240, p < 0.001$, but no difference between the groups before simulation, $F (1, 118) = 1.166, p = 0.282$. In other words, the simulation group had a significant improvement in their CDM scores after participating in simulation, with increased mean CDM scores from 73.03 to 85.54, and the control group demonstrated no change in CDM scores, where the means changed from 75.62 to 76.37 ($p = 0.662$). The effect size

for the interaction is $r_{\text{time vs simulation}} = 0.44$, which is a large effect size.[49]

There was a significant interaction effect between time and year in the curriculum $F (1, 118) = 10.182, p = 0.002$. See Fig. 3. Upon further analysis of the simple effects, the findings were significant at both Time 1 (baseline), $F (1, 118) = 53.393, p < 0.001$, and Time 2, $F (1, 118) = 80.722, p < 0.001$. The second-year students demonstrated statistically significantly higher CDM scores than the first-year students at both time points. Additionally, both groups CDM scores improved significantly between Time 1 and Time 2 (first-years' $p = 0.037$, second-years' $p < 0.001$). The effect size was moderate, r time vs class year $= 0.28$.[49]

There was not a statistically significant three-way interaction between time, class year and simulation group $F(1, 118) = 0.362, p = 0.548$, partial $\eta^2 = 0.003$. The main effect of simulation [$F (1, 118) = 2.016, p = 0.158$] and the interaction of class year and simulation [$F (1, 118) = 0.103, p < 0.749$] were also not significant.

4. Discussion

One simulation experience improved students' CDM skills, regardless of methodology (task trainer versus hybrid simulation). Other studies in physical therapy that have demonstrated changes in CDM had only one or two items pertaining to CDM in the evaluation.[28,31,32,39] In other disciplines, including midwifery, nursing and medical students, previous studies assessing CDM changes after participation in simulation have demonstrated conflicting results regarding the frequency of intervention required. Several studies have demonstrated changes in CDM, critical thinking or clinical reasoning after three to 14 trials of simulation.[31,32,52–59] Shin et al.[60] demonstrated a significant difference in critical thinking and clinical reasoning after participating in three simulation experiences, but no changes were observed after only one or two experiences. Chiang and Chan[61] found results after three simulations, but not after fewer interventions. Shin and Kim[62] found a difference in critical thinking after participating in one session. Shinnick and Woo[63] found no difference in clinical reasoning after one simulation session. The different results across studies are likely due to different protocols and outcome measures used in each of the studies. Given the disparity in the current literature, further research is needed to determine the optimal frequency needed to cause changes in CDM.

This study demonstrated changes in CDM in both hybrid simulation (second-year students) and task trainer (first-year students) simulation. Multiple studies in physical

therapy have demonstrated that participating in a task trainer simulation improves psychomotor skills.[34–37] The present study, however, may be the first one to demonstrate changes in CDM after participation in a task trainer simulation. Further research is necessary to generalize the results to other aspects of physical therapy.

The findings demonstrated an interaction effect of class year. As expected, participants in their second year had significantly higher scores on the CDM tool compared to their first-year counterparts prior to the simulation experience. Clinical decision-making in both groups improved from Time 1 to Time 2; however, the improvement was greater in the second year students. Due to the fact that the type of simulation experience varied between the two cohorts of students, it is unclear whether the interaction can be ascribed to the effects of class year or type of simulation. Regardless, the finding provides known groups validation as the second year students had consistently higher CDM scores than the first year students. The results build on the findings from Brudvig et al.[43]

The study appears to be the first to use a validated CDM measurement to assess changes in physical therapy students' CDM after participating in simulation. This study provides evidence that the CDM tool can measure change as well as the difference between two groups that are likely to have different CDM skills. Thus, these findings contribute to further validation of the CDM tool. These findings are important because there are few reliable and valid tools to measure decision-making across the health professions.[64] While other disciplines have demonstrated improvements in CDM, critical thinking, or clinical reasoning scales after participating in simulation, the tools are specific to the discipline or may not be sensitive to change.[52–54,60–62,65–70] The present tool has the potential to be used across health professions as the items are not physical therapy specific.

4.1. Limitations

There are several limitations to the current study. The participants were from one institution. Demographic data to describe the participants was not solicited. While the literature doesn't suggest that demographic differences lead to differences in CDM, it is unknown if differences in age, gender or other factors might lead to changes in this context. There may have been other differences in the groups that contributed to the results. History and maturation were threats to internal validity and a potential limitation of the study. However, each class year took the same course work which helps to control these effects. Testing is a threat to internal validity as the students repeated the CDM tool within a short period,

between 5 day for the first year students and 21 days for the second year students. It is possible that repeated testing might have yielded different, potentially improved results. However, this is unlikely given the significant findings observed between the simulation and no simulation groups. The CDM tool is a self-report measure, which can limit the reliability of a measure. Students tend to under- or over-rate their abilities compared to socially acceptable norms.[71] Therefore, a self-report tool can create a response bias if students' reflections are inaccurate.[72] Lastly, since this study a shorter version of the CDM tool has been developed with improvements in the psychometric properties.

4.2. Implication of results

The findings support the notion that simulation experiences can result in changes in behavior that could support clinical care of patients and substitute or enhance time in a clinical setting. The study demonstrated improvements in CDM after participating in one simulation. If the results can be replicated, then the use of simulation provides the opportunity to streamline DPT academic and perhaps continuing education. It is important to consider the equipment, training, and cost required to implement simulation in an educational program.

The results substantiate the CDM tool as a possible outcome measure for assessing student progress across a curriculum, and after participating in simulation. The tool is short and easy to administer, making it easy for educational programs to adopt. The Commission on the Accreditation of Physical Therapy Programs has requested that DPT programs increase the use of outcome measures in their evaluation plans.[73] The CDM tool could help to partially satisfy this request.

4.3. Recommendations

It would be beneficial to determine if the results can be replicated at different academic institutions. A future research study comparing the changes in CDM scores after one, two, three or more simulation experiences will help to guide educators about the optimal dosage of simulations to obtain permanent changes in CDM scores. The study was a short-term assessment, either 5 days or 3 weeks between pre- and post-tests. A longitudinal study would be helpful to determine if the observed changes are maintained, even into practice. Future research is needed to compare changes in CDM after a simulation experience to those observed after student participates in a clinical experience. Addition-

ally, studies comparing the effects of different forms of simulation on CDM would be useful.

Ethical approval

This study (Protocol 2015P001844/SRH) was deemed Exempt by the Spaulding Rehabilitation Institutional Review Board (the IRB for the MGH Institute of Health Professions) on September 28, 2015. The study (Protocol 991477-3) was deemed Exempt by the University of Phoenix Institutional Review Board on February 3, 2017.

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